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Agenda Item 3: Air Navigation Services
3.1 CNS/ATM

ATM PERFORMANCE

(Presented by the Secretariat)

SUMMARY

This Working Paper presents ICAO guidelines concerning ATM performance, for States to develop their ATM performance evaluation programmes.

References:

- Annex 11 - *Air Traffic Services.*
- Annex 13 - *Aircraft Accident and Incident Investigation.*
- Doc 4444 PANS-ATM - *Air Traffic Management.*
- Doc 9854 - *Global Air Traffic Management Operational Concept*
- Doc 9828 - *Report of the Eleventh Air Navigation Conference - Montreal, 22 Sept-3 Oct. 2003.*
- CAR/SAM Regional Guidance Material On Air Traffic Services Quality Assurance Programmes - Version 1.0 November 2001.
- Manual on Safety Management for aerodromes and air traffic services (draft version).

1. Introduction

1.1 Annex 11— *Air Traffic Services* and Annex 14 — *Aerodromes* demand that States establish safety management programmes with acceptable objectives and levels concerning the provision of ATS in the airspace and aerodromes under their jurisdiction.

1.2 In accordance with Annex 13 – *Aircraft Accident and Incident Investigation*, States must publish regulations relating to mandatory reporting of accidents and incidents, and of procedures in place for processing and investigating these reports.

1.3 Doc 4444, PANS-ATM, highlights that States should establish systematic and appropriate ATS safety management programmes with defined levels and objectives, which include safety assessment before any significant change to the ATC system in order to prove that the agreed target level of safety (TLS) is fulfilled.

1.4 The Global ATM Operational Concept (Doc 9854) describes the services for the operation of the global air traffic system, up to and beyond 2025. The necessary expectations of the ATM community to increase user's flexibility and to optimize efficiency in order to increase the capacity of the system and to improve safety levels are therein presented.

2 Analysis

2.1 The *Manual on Safety Management for Aerodromes and Air Traffic Services* (draft version), endorsed by the AN-Conf/11, defines the system performance objectives and the mechanisms proving that these objectives are met. Some of these mechanisms are the safety indicators applicable to all the aeronautical system, the development of additional predictive indicators to those expressing the safety level reached, guidelines on acceptable safety levels for all the elements of the system and the related parameters.

2.2 Doc 9854 emphasizes the importance of establishing the system's performance indicators to ensure that the expectations of the ATM community are fulfilled and that new operational procedures are adequately introduced, so that the system may meet the agreed safety levels. Some of these expectations are related with the access and equity, capacity, cost-efficiency, efficiency, environment, flexibility, global inter-operability, participation, predictability, safety and airport security.

2.3 Within the ATM system, safety performance is considered as the most important indicators, as follows:

> *Safety Performance Indicator*. A measure (or metric) used to express the level of safety performance required or achieved in a system.
>
> *Safety Performance Target*. The required level of safety performance for a system. A safety performance target comprises one or more safety performance indicators, together with desired outcomes expressed in terms of those indicators.

2.4 A safety performance target, as defined above, is a criterion against which the results of monitoring of the safety performance of a system are assessed. It is necessary to draw a distinction between the criteria used to assess the safety performance as assessed through monitoring, and the criteria used for the assessment of the safety of new systems or procedures.

2.5 A hazard analysis approach involves estimating qualitatively or quantitatively the degree of risk associated with each identified hazard, and incorporating mitigation measures, as necessary, to ensure that the risk associated with each hazard is adequately controlled. The hazard analysis approach does not necessarily produce quantitative estimates of safety which can be directly compared to the same safety performance indicators, which are used to assess the results of monitoring.

Safety performance indicators

2.6 Safety performance indicators are generally expressed in terms of the frequency of occurrence of some event causing harm. Typical measures which could be used include:

- fatal aircraft accidents per flight hour;
- fatal aircraft accidents per movement;
- fatal aircraft accidents per year;
- serious incidents per flight hour;
- fatalities due to aircraft accidents per year.

2.7 Risk measures expressed in terms of fatal aircraft accidents are indicators of individual risk, since they do not take account of the number of people affected. A risk measure expressed in terms of number of fatalities would be more appropriate for expressing societal risk.

2.8 These risk measures specify only the frequency of occurrence, whereas we noted earlier that risk involves both frequency and severity. In this form of risk measure, the severity is implicit in the occurrence whose frequency is being specified. Therefore it could be expected that an acceptable limit expressed in terms of incidents would be significantly different from a limit expressed in terms of fatal aircraft accidents.

Safety performance targets

2.9 In order to set a safety performance target, first of all it is necessary to decide on an appropriate safety performance indicator, and then to decide on what represents an acceptable outcome. ICAO has set a global safety performance target in the specification of the objectives of the Global Aviation Safety Plan (GASP), as follows:

a) to reduce the number of accidents and fatalities, irrespective of the volume of air traffic; and
b) to achieve a significant decrease in worldwide accident rates, placing the emphasis on regions where these remain high.

Choice of the safety performance indicator

2.10 There is no single safety performance indicator which is appropriate in all circumstances. The indicator chosen to express a safety performance target must be matched to the application in which it will be used, so that it will be possible to make a meaningful evaluation of safety in the same terms as those used in defining the safety performance target.

2.11 The safety performance indicator(s) chosen to express global, regional and national targets is not generally appropriate for application to individual ATS units. The ICAO global target, for example, is expressed in terms of accidents. However, aircraft accidents are relatively rare events. Even at the global level, accident rates vary considerably from year to year. An increase or decrease in accidents from on year to the next does not necessarily indicate a change in the underlying level of safety.

Safety performance monitoring and investigation

2.12 The term safety assessment criteria will be defined as the set of quantitative or qualitative criteria to be used in a safety assessment to determine the acceptability of the assessed level of safety. The implementation of an effective safety performance monitoring programme requires that ATS providers:

a) determine appropriate safety performance indicators;

b) set safety performance targets;

c) establish a safety occurrence reporting system, mandatory and voluntary;

d) establish a system for the investigation of safety occurrences;

e) develop procedures for the integration of safety data from all available sources; and

f) develop procedures for the analysis of the data and the production of periodic safety performance reports.

2.13 The requirements and procedures for safety performance monitoring and investigation should be fully documented in the organization's safety management manual.

Classification of safety occurrences and causal factors

2.14 It is much easier if events and causal factors are classified using a standard scheme, and the classified data are entered into a data base. A classification scheme (also called a *taxonomy*) is comprised of a hierarchy of classes of events. The top levels are very broad in scope, while each succeeding lower level becomes more specific

2.15 ICAO has maintained a global data base of accidents and serious incidents notified by States through the Aircraft Accident/Incident Data Reporting System (ADREP). The latest version of this system, called ADREP 2000, contains a greatly expanded taxonomy including many ATS-related categories. Information on this system, including copies of the taxonomies, can be found on the Internet at *http://eccairs-www.jrc.it/*

2.16 It is recommended that these taxonomies be used for classification of ATS-related safety occurrence data for internal investigation and analysis purposes, as well as for reporting accident and incident data to ADREP.

2.17 In all cases where safety occurrence data is entered into a data base, it should be borne in mind that the validity of the information derived from any data base will only be as good the data on which it is based. Therefore, it is important that the accuracy of the entered data is verified.

Safety Assessment Process

2.18 Significant work in the field of performance objectives has recently been undertaken by ICAO with the assistance of the Air Navigation Services Economics Panel (ANSEP). The revised guidance material on measuring performance and productivity in the Manual on Air Navigation Services Economics (Doc 9161) includes an approach to development of performance metrics in, inter alia, the areas of safety, delay, flight efficiency, productivity and cost-effectiveness.

2.19 A primary purpose of performance measurement is the assessment and improvement of performance over time within an air navigation services organization. Comparing different organization's performance can be beneficial in understanding performance drivers and shortfalls and thus establishing best practices. Comparisons between providers and air navigation services should take into account the differences in organization structure and airspace complexity. Performance metrics can be applied to all air navigation services (ATM/AIS/CNS/MET).

2.20 The safety assessment is a systemic approach, as whole criteria to evaluate the acceptability of the risk and incorporate severity and likelihood aspects. In the **Appendix A** to this Working Paper the seven steps of the complete process are pointed out.

2.21 The perceived risk associated with a hazardous event depends on both the likelihood of occurrence of the event, and the severity of its consequences. The safety assessment process needs to address both these factors. The **Appendix B** to this Working Paper has the risk classification scheme.

2.22 If the initial assessment of the risk indicates that it does not satisfy the safety assessment criteria, requiring the introduction of mitigation measures, it will be necessary to re-evaluate the risk in order to determine the mitigation measures for the desired effect. This means that some of the previous steps should be repeated. The process may, in fact, need to be repeated more than once, until a satisfactory combination of mitigation measures is found.

2.23 Additionally, the ATM Requirements and Performance Panel (ATMRPP) is working to finalize a set of ATM system requirements that will guide development of technical SARPs and guide ATM research and development, manufacturing and implementation planning activities.

ATS Quality assurance programmes

2.24 In order to support the implementation of quality assurance programmes, since 2003 the ICAO NACC Office has carried out several special implementation projects (SIPs) for the Central Caribbean, the Eastern Caribbean and Central America. The main objective of these SIPs was to provide in situ assistance for the implementation of Quality Assurance Programmes. Most of the States, Territories and International Organizations reported substantial progress on the implementation of these programmes.

2.25 ATS Quality Assurance Programmes have proved to be an efficient tool that fosters improvements to the ATM system through the establishment of diverse complementary programmes for ATS performance assessment such as incidents reporting and investigation programmes; incidents prevention; verification and training on ATC proficiency; proficiency in the use of aeronautical language and of English language; verification of the use of aeronautical phraseology.

2.26 Although these implementations have attained great success in the solution of deficiencies, it is necessary to consider other aspects related with the assessment of ATM performance in order to achieve a harmonious migration towards the implementation of safety management systems in the CAR and NAM Regions.

2.27 The NACC Regional has developed a database on ATS incidents which occurred in the CAR/SAM Regions, whose purpose is to register the safety measures carried out by States, Territories and International Organizations, and that are included in the Air Traffic Services Quality Assurance Programme.

3. Conclusion

3.1 The implementation of a safety management programme requires more than a general statement on the fact that safety is critical; it demands definition of related performance objectives, and implementing a mechanism to prove that these objectives are being met. This implies undertaking new work to measure the ATM system's performance. Among these aspects is sharing information on incidents and accidents online, the classification of risk and the suitable measures to its solution, as well as the regional collaboration for the harmonization and exchange of experiences.

3.2 The review of safety and of the required performance of the system, the analysis of the cost/benefit aspects, the commercial assessment as well as the inter-operability of the system will foster possible solutions for the States. The results of the ATM performance assessment shall not be under the minimum accepted levels of safety.

3.3 States should support the implementation of ATM performance assessment programmes. The objective is to face the risks in the general aeronautical system in which ATS may constitute a contributory factor, as well as to control the process that may lead to hazardous events and to reduce to the minimum the probability of accidents occurrence.

3.4 Likewise, the enhancements to safety, finances and the efficiency through the adoption of collaborative decisions towards the evolution of a holistic and co-operation environment should be facilitated to fulfill the expectations of the ATM community, as well as to improve safety of all the system in a balanced manner, in order to attain the best results.

4. Suggested action

4.1 The Meeting is invited to:

a) note the information presented in this Working Paper;

b) support the implementation by **30 November 2006** of an ATM performance assessment programme, in accordance with ICAO guidelines; and

c) recommend other actions as deemed appropriate.

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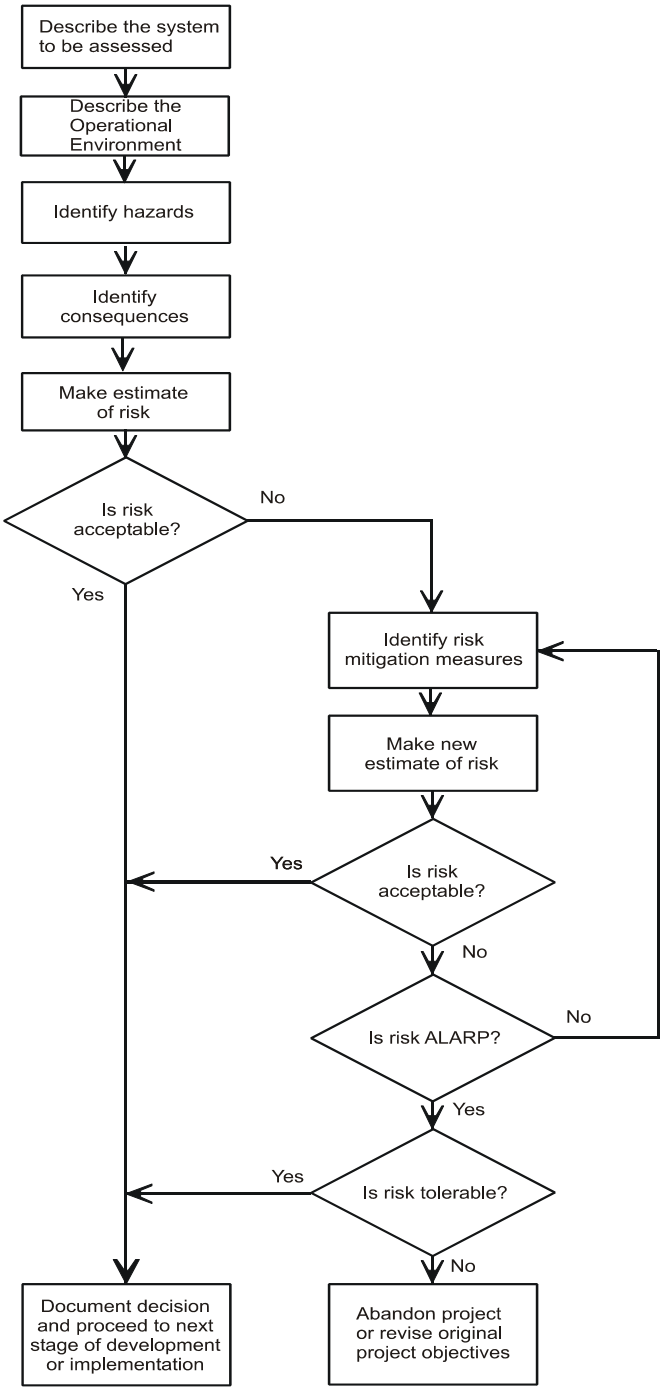
APPENDIX A

SEVEN STEPS OF THE SAFETY ASSESSMENT PROCESS



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APPENDIX B

RISK CLASSIFICATION SCHEME

Since the acceptability of a risk is dependent on both its likelihood and the severity of its consequences, the criteria used to judge acceptability will always be two-dimensional. Acceptability is usually based on comparison with a severity/probability matrix.

		Probability of Occurrence				
		Extremely improbable	**Extremely remote**	**Remote**	**Reasonably probable**	**Frequent**
Severity	Catastrophic	Review	Unacceptable	Unacceptable	Unacceptable	Unacceptable
	Hazardous	Review	Review	Unacceptable	Unacceptable	Unacceptable
	Major	Acceptable	Review	Review	Review	Review
	Minor	Acceptable	Acceptable	Acceptable	Acceptable	Review

Once the assessment of acceptability of the risk has been completed for all the identified hazards, the results, including the rationale for the classifications chosen, should be recorded in the hazard log. It is particularly important that all cases where the risk has been accepted and tolerable are well documented, and that the justification for the decision is clearly specified.

Risk Mitigation

If the risk does not meet the pre-determined acceptability criteria, an attempt should always be made to reduce it to a level which is acceptable, or if this is not possible, to a level as low as reasonably practicable, using appropriate mitigation procedures.

The identification of appropriate risk mitigation measures, requires a good understanding of the hazard and the factors contributing to its occurrence, since any mechanism which will be effective in reducing risk will have to modify one or more of these factors.

Risk mitigation measures may work through reducing the probability of occurrence, or the severity of the consequences, or both. Achieving the desired level of risk reduction may require the implementation of more than one mitigation measure. The possible approaches to risk mitigation include:

a) revision of the system design;
b) modification of operational procedures;
c) changes to staffing arrangements; and
d) training of personnel to deal with the hazard.

The earlier in the system life cycle that hazards are identified, the easier it is to change the system design if necessary. As the system nears implementation, changing the design becomes more difficult and costly. This could reduce the available mitigation options for those hazards which are not identified until a late stage of the project.

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